Canadian Space Agency | Agence spatiale canadienne

Educational Product	
Teacher's Edition	Grades 4-8

Neurolab for Classrooms

Canadian Space Agency Educational Materials for STS-90 Neurolab

Canada

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DEAR EDUCATORS

Welcome to the STS-90 Mission Classroom Materials!

The Canadian Space Agency's primary educational goal is to interest Canada's young people in science, technology, space and space-related careers. This curriculum resource material is intended to provide teachers across Canada with an opportunity to present their students with enriching learning experiences based on the STS-90 Mission.

The activities are designed to be hands-on and fun for students of varying ability while providing an engaging and accurate glimpse into the science of the mission.

Although the materials fit most readily into a life-science curriculum, this resource is varied and accessible enough to be useful in other subjects, for example, in a physical education class where the relationship between the eyes and the muscles could be explored. As a further example, the students could research and report on Canada's space history or do creative writing dealing with gravity and microgravity as part of a language arts curriculum. And, a social science class could research the implications of human migration into space as a result of the experimental findings of STS-90.

Feel free to distribute and adapt the material as you see fit – it was written for you and your class.

As our front line representative, we at the Canadian Space Agency thank you for helping us prepare Canada's young people for the challenge of space in the next millennium.

Dave Williams in training

Canada in Space

Humans have gazed heavenwards since the dawn of time. They have wondered who or what is in the vast expanse of space. Without reliable information, they set about explaining the sun, the planets, the stars, and other heavenly bodies in terms they could understand, in the context of their own existence.

They imagined all sorts of creatures – animals and gods – as controlling the movements they perceived in the sky. Perhaps the sun was pulled by a charioteer and a mighty steed! Perhaps the Earth sat on the back of a giant tortoise!

Until the invention of the telescope, there were countless conflicting theories about the universe. New theories replaced old ones as the mysteries began to unfold one halting step at a time. Still, space lay like a vast, seemingly limitless expanse of wonder.

Only in the 1950s did it become feasible to send an object beyond the boundaries of the Earth. Canada's role in the evolving adventure of exploring the cosmos began with the establishment of the Churchill Rocket Range, Manitoba, where the first rockets were launched into the upper atmosphere. The chronology on p. 5 highlights Canada's continuing space efforts.

In 1989, the Canadian Space Agency was established to manage Canada's ongoing commitment to space exploration and research.

Dave Williams in training

A CHRONOLOGY

1957

The Churchill Rocket Range, Manitoba, was established to explore the upper atmosphere using rocket-launched payloads.

1959

Canada and NASA signed an agreement under which NASA would provide launching facilities for *Alouette*, Canada's first satellite.

1962

Canada became the third country ever to have a spacecraft in orbit – the *Alouette* satellite. This began a series of Canadian launches during the late 60s and throughout the 1970s.

1981

The Canadarm was first used operationally aboard the Shuttle *Columbia*.

1984

Marc Garneau became the first Canadian in space, as he flew aboard the Shuttle *Challenger*.

1992

Roberta Bondar flew in the first of the series of space shuttle flights dedicated to life sciences research. She became the first Canadian woman in space.

1992

Steve MacLean flew aboard the *Columbia* Mission STS-52 where further life sciences experiments were concluded.

1995

Chris Hadfield was the first Canadian to operate the Canadarm in space and the first and only Canadian to board the Russian Space Station *Mir*.

1996

Marc Garneau celebrated his second flight into space during the STS-77 Mission.

1996

Robert Thirsk participated in the slate of experiments conducted during the 17-day Life and Microgravity Science mission.

1997

Bjarni Tryggvason was Payload Specialist on the STS-85 Mission, focusing on tests using the Microgravity Vibration Isolation Mount (MIM) and various experiments to examine sensitivity to spacecraft vibrations.

1998

Dave Williams was the first Canadian Crew Medical Officer for a shuttle mission flight. He participated in the experiments on the nervous system conducted during the STS-90 Neurolab.

THE MISSION

The STS-90 mission, or Neurolab, was one of a series of NASA research missions dedicated to the study of life sciences. This mission was a very exciting quest that joined the two remaining frontiers of the 20th century, outer space and inner space - the flight of *Columbia* coupled with research into the workings of the human nervous system. The focus of Neurolab's research is the neurosciences.

The 17-day international mission directed its attention to the effects of weightlessness on the nervous system, the most complex and least understood parts of the human body. Made up of the brain, spinal cord, nerves and sensory organs, these systems face major challenges during space flight. They are involved in the regulation of blood pressure, co-ordination of movement and sleep regulation – all of which are affected on a space shuttle mission.

During the flight of Neurolab, astronauts conducted life science experiments in the shuttle *Columbia's* Spacelab module, a fully equipped international space laboratory. The co-ordinated efforts of thousands of scientists, engineers and astronauts from across Canada, the United States, Europe and Japan were involved in the success of this mission.

THE SCIENCE

Two of the 26 Neurolab experiments, chosen by NASA from about 170 proposals, involved Canadian Investigators. One of these experiments, *Visuo-Motor Co-ordination Facility (VCF)*, involved a study of changes in movement during weightlessness that affect such things as pointing to and grasping objects. This project may provide insights into muscular performance on Earth with implications for recovery after injuries. The Canadian co-investigator for this experiment, Dr. Barry Fowler, is a scientist at York University in Toronto.

The other Canada experiment, the *Role of Visual Cues in Spatial Orientation (Visual Cues)*, studied the process by which astronauts orient themselves in microgravity. It examined how they switch from reliance on their inner ear balance organs (which they use on Earth) to using strictly visual cues. The investigation looked at the use of "fake gravity" by putting pressure on the bottom of the feet to see if it could override the visual cues, and how long it would take to re-adapt on return to the Earth. These results may have a bearing on motion sickness both on Earth and in space. The Canadian co-investigator for this experiment, Dr. Ian Howard, is a scientist at the Human Performance Laboratory of the Center for Research and Space Technology (CRESTech) in Toronto.

> *"Neurolab seeks to explore the remaining two frontiers of the 20th century: space and the human nervous system. The mission provides us with a unique opportunity to capture the imagination of students to further understand human physiology and how humans relate to the world in which we live."*
>
> *Dr. Dave Williams*

THE IMPORTANCE OF NEUROLAB

Neurolab focused on basic research in neuroscience, providing a unique opportunity to study neurological diseases and disorders in a microgravity environment and to investigate potential treatments and therapies. While the mission's main aim was to expand our understanding of how the nervous system develops and functions in space, this knowledge may have direct applications to its development and function on Earth.

Aptly called "the last frontier of human biology", neuroscience research holds infinite possibilities for greater understanding of how the nervous system works and for treating and preventing nervous system ailments.

With all of the data collected over the years on how astronauts adapt to microgravity, researchers are beginning to understand the basics of space physiology, and the experience has posed as many questions as it has answered.
For example:

- How do we learn to function so quickly without gravity, given that all our basic movements (walking, catching, etc.) were learned in the presence of gravity?
- How do the gravity-sensitive parts of the body like the inner ear, cardio-vascular system and muscles learn to cope without gravity?
- Why are sleep and biological rhythms changed in space?
- Must gravity be present at the point in life when basic skills such as walking are usually learned?

These questions were explored on the mission by taking measurements on the crew and research animals before, during and after the flight. The experiments on the crew included blood presssure, eye-hand co-ordination, inner ear research with emphasis on balance, and the problems associated with sleep.

The absence of gravity is a unique research environment with some fascinating possibilities for advancing the treatment of disease.

- For the over half million North Americans with orthostatic intolerance (e.g. dizziness from standing too quickly), Neurolab research may help define the disorder, bringing therapeutic intervention closer;
- Neurolab research using head-mounted Virtual Reality displays studied the effects of disease and trauma on the inner ear which senses balance and motion. This condition affects over 90 million North Americans. The results may suggest the possibility of visual prosthetics as a treatment approach;
- Insomniacs may be aided by advances in understanding of how the "sleep hormone" melatonin, functions, as well as by the development of novel portable equipment for home-based sleep studies;
- New knowledge of neuronal plasticity, the way nerve cells "re-wire" to compensate for disease or injury, may aid in many areas of nervous system therapy;
- The role of gravity in the development of the mammalian nervous system was studied, offering insights into how genetics and the environment interact during this crucial process;
- An on board aquatic system may shed light on various forms of motion sickness and disorientation.

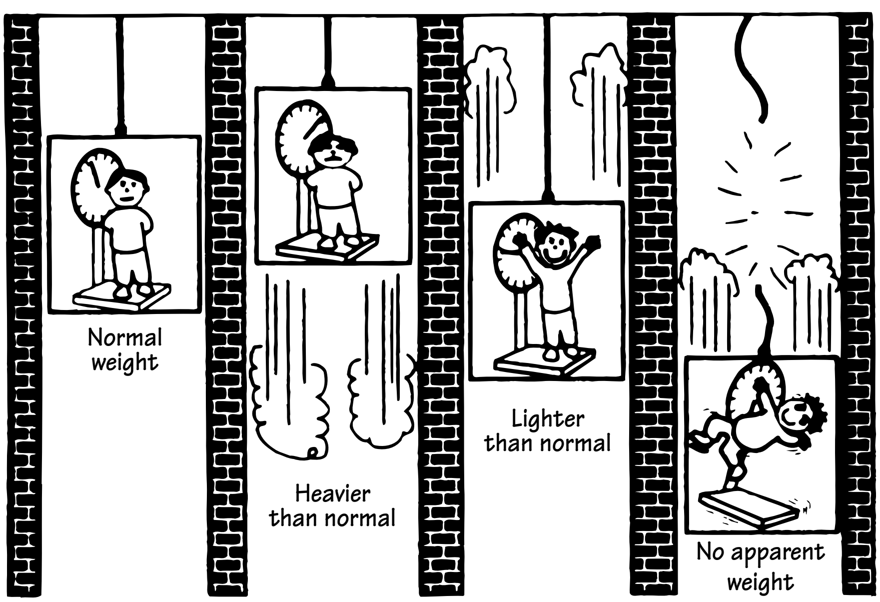
THE IMPORTANCE OF NEUROLAB

Gravity and Microgravity

Gravity is a force that causes an action on a body, usually as a downward pull. It is the force associated with mass and can act without contact. *Resistive forces* counter gravitational pull so that the two together result in a net force of zero.

Microgravity is an environment where the effects of gravity are very small. The extent to which gravity seems to disappear – the quality of microgravity that is achieved – is the extent to which the resistive forces are eliminated.

Gravity and resistive forces affect the human body externally. On Earth, gravity acts uniformly on all parts of the body, but resistive forces act only on contacting surfaces such as the ground and a person's feet. The total force on the human body is zero because the body reacts to distribute the force evenly throughout even though the resistive force acts only on the feet. In a microgravity environment, the resistive forces are very small and therefore, there is no internal force distribution.



Acceleration and Weight
The person in the stationary elevator car experiences normal weight. In the car immediately to the right, apparent weight increases slightly because of the upward acceleration. Apparent weight decreases slightly in the next car because of the downward acceleration. No weight is measured in the last car on the right because of free fall.

NASA Microgravity – A Teacher's Guide with Activities in Science, Mathematics and Technology, EG-1997-08-110-HQ, Education Standards Grades 5-8

CANADIAN ASTRONAUT DAFYDD (DAVE) RHYS WILLIAMS, M.D.

Dr. Dave Williams was the Crew Medical Officer on the STS-90 Mission. He was born in Saskatoon, Sackatchewan on May 16, 1954, and as a young child moved to the rural community of Beaconsfield, near Montreal, Quebec. Among his pastimes were horseback riding, fishing and canoeing.

Dave remembers trading space cards with his friends during the time of the Mercury and Gemini programs and thinking of becoming an astronaut, although he didn't consider it a real possibility at the time. He was more interested in becoming an aquanaut and living in an underwater environment. By the age of 13, he had completed all the children's swimming and lifesaving classes and an adult SCUBA diving course. While an undergraduate in university, he earned his tuition as a lifeguard swimming instructor and examiner, a skiing instructor and a NAUI (National Association of Underwater Instructors) SCUBA instructor.

At McGill University, Dr. Williams earned his B.Sc. in Biology, his M.S. in Physiology and his M.D. and Master of Surgery degrees. He completed a Family Practice residency from the University of Ottawa and an Emergency Medicine residency from the University of Toronto, as well as a Fellowship in Emergency Medicine from the Royal College of Physicians and Surgeons of Canada. He is an assistant professor of medicine at the University of Toronto.

His wife, Cathy, is a commercial pilot and flying instructor. It was during a presentation describing Canada's astronaut program that Marc Garneau made at the flying club where she taught that she nudged her husband and said: "You should be doing this." Nine years later, Dr. Williams' interests and abilities had taken him in just that direction.

The Canadian Space Agency (CSA) selected him for astronaut training and then appointed him manager of the Missions and Space Medicine group within the Astronaut Office. In 1994, he served as a crew member and Crew Medical Officer on a seven-day space mission simulation and was Principal Investigator of a study to evaluate the initial training and retention of resuscitation skills of non-medical astronauts. A member of the 1995 NASA astronaut class, he worked on technical issues for the Payloads/Habitability Branch of the Astronaut Office at Johnson Space Center. Dr. Williams is now head of NASA's Space and Life Sciences Directorate.

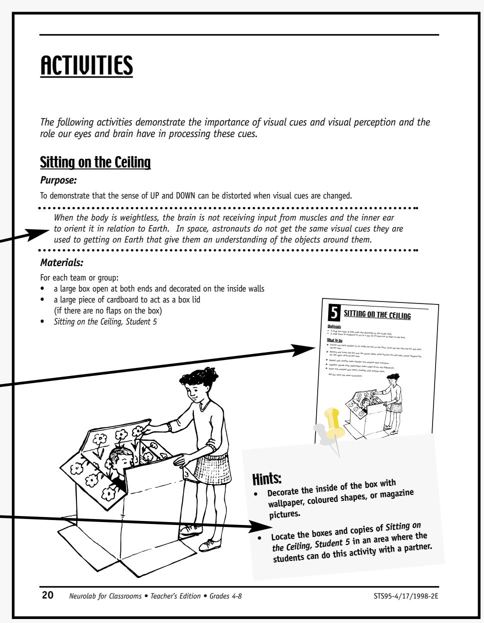
STS-90 MISSION CREW

Left to right: Payload Specialist: James (Jim) Pawelczyk; Mission Specialist: Richard (Rick) M. Linneham; pilot: Scott D. Altman; Mission Specialist: Kathryn (Kay) P. Hire; Commander: Richard A. Searfoss; Mission Specialist: Dafydd (Dave) Rhys Williams; Payload Specialist: Jay C. Buckey Jr.

Neurolab for Classroom

The teacher's edition includes a number of special features that make this resource easy to use.

- ➤ Highlighted information to clarify specific concepts.
- ➤ Cross-reference to corresponding student pages on the teacher pages for each activity.
- ➤ Hints for implementation and safety notes.



ACTIVITIES

The following activities demonstrate the importance of visual cues and visual perception and the role our eyes and brain have in processing these cues.

Sitting on the Ceiling

Purpose:

To demonstrate that the sense of UP and DOWN can be distorted when visual cues are changed.

When the body is weightless, the brain is not receiving input from muscles and the inner ear to orient it in relation to Earth. In space, astronauts do not get the same visual cues they are used to getting on Earth that give them an understanding of the objects around them.

Materials:

For each team or group:
- a large box open at both ends and decorated on the inside walls
- a large piece of cardboard to act as a box lid (if there are no flaps on the box)
- *Sitting on the Ceiling, Student 5*

Hints:
- **Decorate the inside of the box with wallpaper, coloured shapes, or magazine pictures.**
- **Locate the boxes and copies of *Sitting on the Ceiling, Student 5* in an area where the students can do this activity with a partner.**

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THE VISUO-MOTOR CO-ORDINATION FACILITY (VCF) EXPERIMENT

Introduction

The *Visuo-motor Co-ordination Facility (VCF)* experiment was designed to measure the subtle loss of eye-hand co-ordination that happens when astronauts enter microgravity.

Since all human life developed under the pull of gravity, our motor skills and sense organs are pre-programmed to take gravity into account whenever we move. In space, the near weightless environment causes the brain to get confusing messages. As a result, the instructions sent back from the brain to the muscles do not always lead to effective eye-hand coordination.

Poor co-ordination in space is a result of the change in perception that occurs in the absence of gravity. Simple distances are often misjudged. And the astronauts' muscle responses may not match the visual cues or touch sensations that they are experiencing.

The VCF experiment was performed by four astronauts before, during and after the flight. During half-hour sessions, their eye-hand co-ordination was measured while they pointed at flashing dots, and tracked and grasped for simulated objects that were generated by virtual-reality.

The results of this experiment will be used to find the best way to help astronauts adjust to microgravity and to develop systems that may improve pilot and passenger safety during flights. For example, engineers may use the results to help them design safer cockpit instrumentation in space shuttles and high-speed aircraft. If a pilot's reaction to on-going or sudden periods of weightlessness can be anticipated, then better placement of cockpit instruments could compensate for their limited co-ordination.

Vocabulary

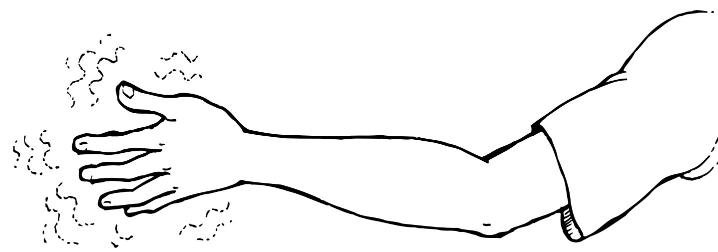
Microgravity - a level of gravity MUCH less than Earth's gravity

Weightlessness - the absence of any feeling of weight

SETTING A CONTEXT

Class Discussion

➤ To introduce the idea of loss of co-ordination, invite students to respond to the following questions:



- Have you ever had a leg, an arm or a foot "fall asleep"?
- How did it feel when you tried to walk or reach out for something?
- Did you feel a sudden loss of control over that part of your body?
- What might happen if a driver of a car had his or her leg "fall asleep"?
- Would the driver be able to react as quickly and as accurately?

What is Gravity?

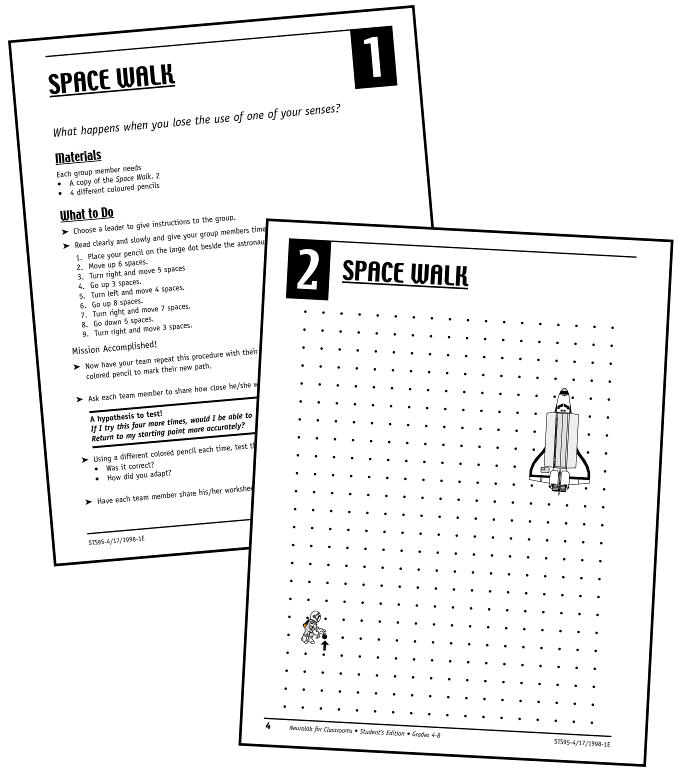
➤ Review with the students what gravity is.

➤ Introduce the idea of microgravity. In doing so you might choose to compare movement in the water to movement on land, pointing out that in water certain movements are slower (running). In a microgravity environment, movement is much faster and takes less controlled effort.

ACTIVITIES

The following activities demonstrate some of the situations to which astronauts must learn to adjust.

Space Walk



Purpose:

To understand what happens when we lose the use of one of our senses.

Materials:

For each team or group:
- *Space Walk, Student 1*

For each team or group:
- *Space Walk, Student 2*
- 4 different colored pencils

➤ Have students work in small groups or teams to complete this activity.

➤ Identify a group or team leader who will give the instructions while the remainder of the students complete the tasks.

➤ Distribute the materials and review the procedure with them. Make sure that the students note that they are to complete the task first with their eyes open and then with their eyes closed.

Extensions:

➤ Have the students actually go on a directed space walk. Mark a starting point on the classroom floor and a target destination for them to reach. Give oral instructions for the path they must take to reach their destination.

➤ In discussion, relate their classroom space walk to the fact that in many situations, astronauts in space have to follow spoken instructions or directions given from as far away as NASA!

Hint:
Take into account that student steps may not all be the same size!

ACTIVITIES

Dizzy Circles

Purpose:

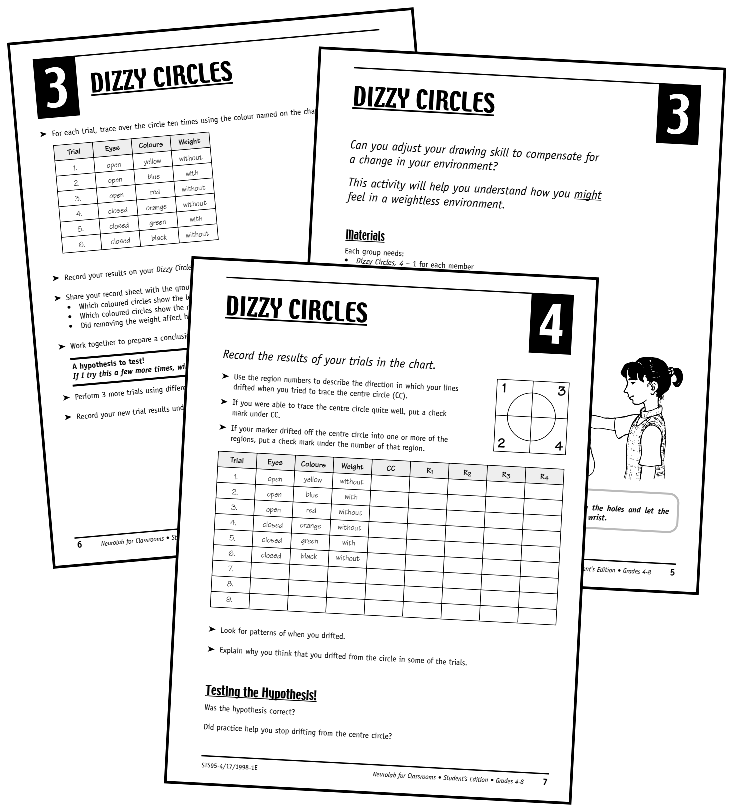
To find out whether students can naturally readjust their movements when extra resistance is applied to their writing arm and/or visual cues are eliminated.

The assumption is that extra resistance caused by weights on their forearm can create a need for correcting their movements, and that closing their eyes illustrates how they depend on visual cues to perform tasks.

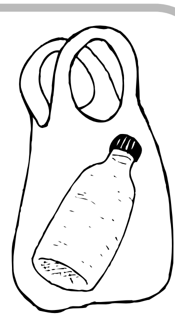
Materials:

For each team or group:
- *Dizzy Circles, Student 3*
- set of 6 different color markers, crayons, or pencils (yellow, orange, red, blue, green, black)
- a weight

For each student:
- *Dizzy Circles, Student 4*
- paper (approx. 50 cm by 50 cm)



To make weight:
- Fill a one litre plastic bottle with water and tighten the cap.
- Put the bottle into a plastic shopping bag with handles.



➤ Have students work in pairs or in small groups of 3-4 to complete this activity.

➤ Provide each group with the materials.

➤ Discuss the procedure and ask students to suggest a hypothesis for each trial. Record these hypotheses on the chalkboard.

➤ Encourage them to move directly from one trial to the next as their reflexes will quickly return to normal once the weight is removed.

For younger students, you may wish to prepare the posters ahead of time.

ACTIVITIES

Dizzy Circles

➤ After students have completed the trials, ask them to present their conclusions.
- Were they able to make allowances for having had the extra weight added to their arm?
- What happened when the weight was removed?
(They may indicate that their arms felt «heavy» and they couldn't direct their movements).

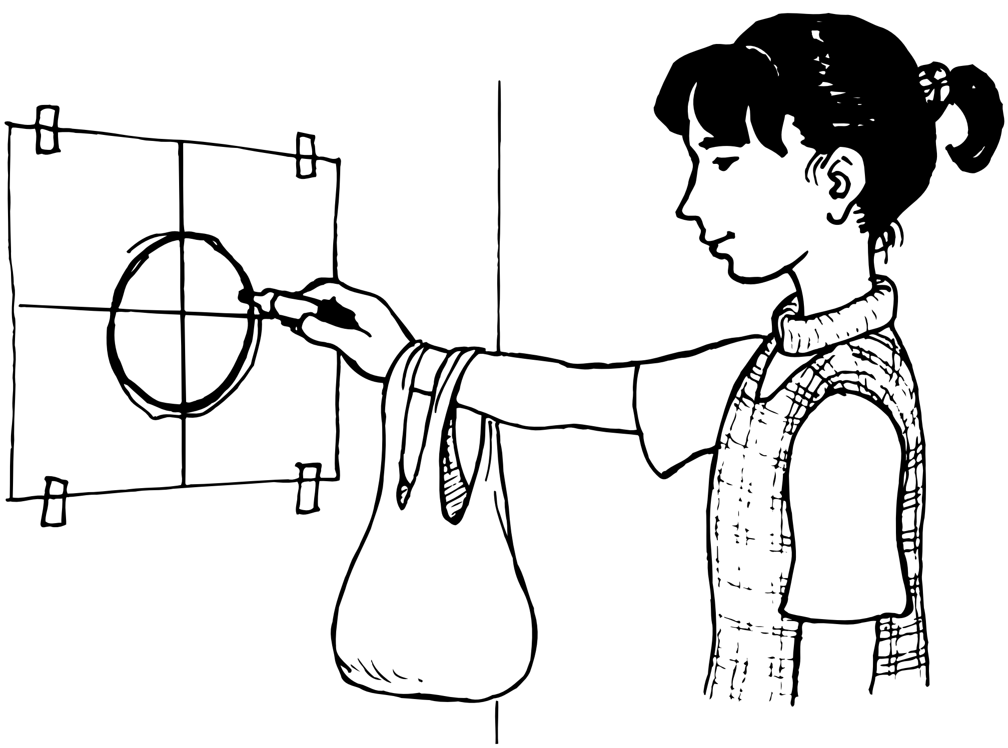
In this experiment, the students do not actually simulate the lack of gravity. But by increasing the weight and then removing it, students see how microgravity might affect their movements.

➤ Explain that the astronauts experience a similar loss of eye-hand co-ordination in microgravity.

➤ Have them suggest how the astronauts might improve their ability to perform tasks in microgravity and have them give reasons for their ideas.

Extension:

➤ Suggest that students repeat the experiment and time each trial. Have them measure the time it took to readjust to their original skill level when the weight was added and after it was removed, both with their eyes open and closed.



VISUAL CUES IN SPATIAL ORIENTATION EXPERIMENT

Introduction

The Role of Visual Cues in Spatial Orientation experiment was designed to help astronauts find out how they orient themselves in microgravity.

Normal activity on Earth such as walking, standing, sitting and working with the hands requires the brain to interpret and integrate information from all the body's senses (touch, hearing, sight, etc.). Once the brain processes this information, it gives feedback to the body on how limbs are positioned, how the entire body is oriented (up or down, right or left), and which muscles should be moved to re-orient the body. Human beings orient themselves in relation to their spatial environment using both gravitational cues from their body and visual cues such as the walls of a room.

In microgravity, there are no gravity cues and astronauts often lose this sense of UP and DOWN. They could actually be working upside down in the Spacelab. Their inner ear, muscles, joints and skin cannot rely on gravity as a constant indicator of position and orientation. The brain must rearrange the relationships among the signals from these sensory systems when it processes the information in order to produce correct responses. This rearrangement requires a period for the body to adapt. Prior to this, the astronauts can get the illusion that their bodies or their environment are moving when both are actually stationary.

On Earth, gravity pulls us to the ground and that is how we determine where DOWN is. UP is opposite to DOWN and so we think of the sky as being UP. Due to our natural tendency to remain upright on Earth we say that UP is above our heads and DOWN is where our feet are.

STS-90 crew member Jim Pawelczyk

ACTIVITIES

The STS-90 astronauts tested their orientation capabilities in three different rooms before and after the mission:

1. a cube-shaped room with furniture to give cues as in a normal Earth room
2. a cube-shaped room with no furniture to give cues
3. a spherical room in which there is no UP or DOWN.

While on the space shuttle, they used virtual-reality versions of these three rooms for the tests.

The results of this experiment may be used to find out more about motion sickness. This is one of the more serious problems of human travel, both in space and on Earth. Motion sickness on Earth is nausea and dizziness induced by motion. Space motion sickness may be caused by a conflict between visual cues and inner ear and somatic sensations (pressure on the feet or seat) but the feeling of nausea and dizziness is the same.

Dave Williams at CRESTech Labs in a cubic room rotated 180 degrees

Vocabulary

Adapt **– to become adjusted to an environmental condition**

Binocular Vision **– Our two eyes provide us with images from slightly different positions on either side of the nose which our brain combines into one view**

Disorient **– to confuse a person or make a person lose his/her bearings**

Gravity **– the natural force which causes all objects on Earth to move toward the center of the Earth**

Microgravity **– the environment in space that has very little gravity**

Optical Illusion **– a picture or scene that tricks the brain into believing a false image is correct**

Perception **– awareness of objects or space gained by using the senses**

ACTIVITIES

Setting a Context

Class Discussion

➤ Prepare visual test cues ahead of time by turning several items in the classroom such as signs and pictures upside down and by printing the date or other simple messages upside down.

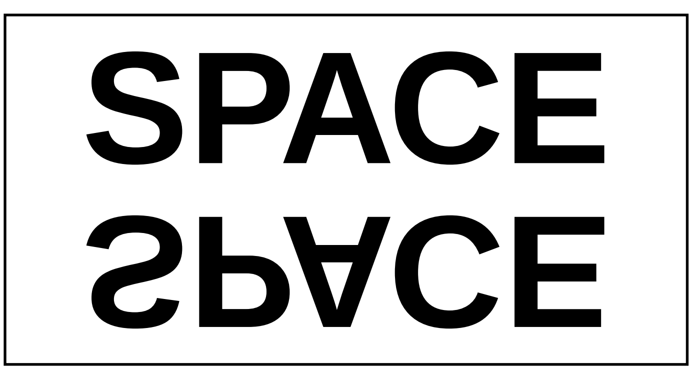
➤ Ask the following questions:
- How did you feel when you first entered the classroom?
- What did you notice that was different?
- When and where do you see things upside down?
- Does it take longer to read words or statements that are upside down?
- How could you improve your skill at reading upside down?
- What might it be like to read important signs that are upside down?
- What words might an astronaut find upside down in the microgravity environment of the spacecraft?

Upside Down Writing

➤ Perform this task on the board while the students do it individually on paper.

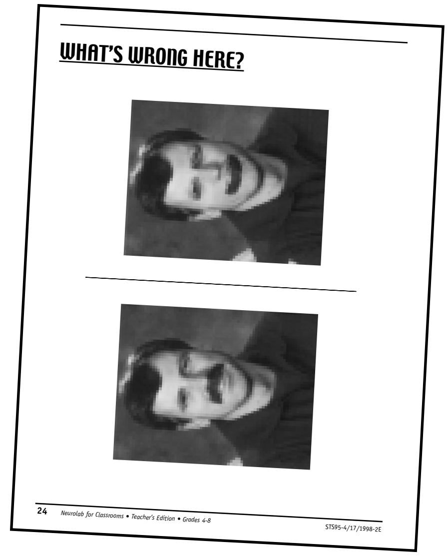
➤ Print the word SPACE in large block letters. Cover it.

➤ Now write SPACE upside down in large block letters. Compare the two words.
Ask:
- Why do you think it was easier to write SPACE right side up?
- How could you improve your skill at writing upside down?
- Do you think this skill would become easier if you practised?
- How do you think astronauts could improve their skills for working upside down?



ACTIVITIES

What's Wrong Here?


WHAT'S WRONG HERE?

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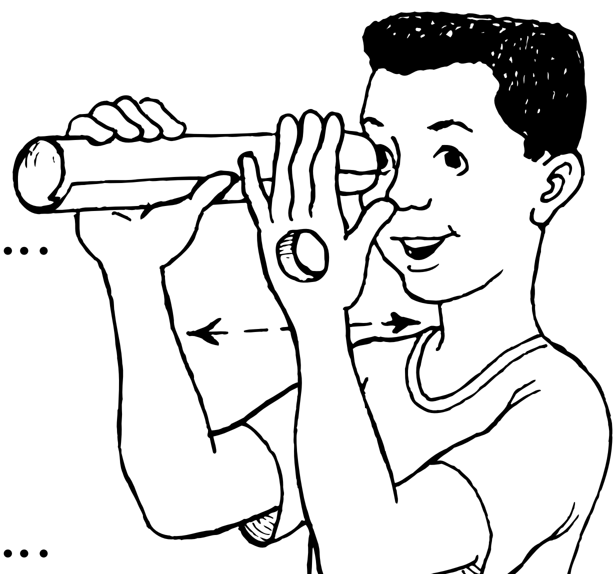
- ➤ Fold the sheet, p. 24 with Dr. Williams' photos in half and show students the first image inverted for only a few seconds. Invite them to tell what they saw. Show the second image inverted for a few seconds and have them tell what they see. Then, show them both photos side by side with the images upward and have them comment.
- ➤ Introduce the fact that astronauts in space are faced with misperceptions on a daily basis. Ask students to suggest how this problem might affect their speed and accuracy at performing tasks.

Our perceptions can be wrong when things are not the way we expect them to be. When we look at a face, we are conditioned to focus on the eyes and mouth for a sense of up and down, without really looking for details.

A Hole-y Hand



- ➤ To demonstrate that each one of a person's eyes perceives objects differently than the other and that both eyes must work together to create the full effect of an image, guide your students through this simple experiment.

Our eyes are meant to work together to give us stereo vision. Our brain tries to compensate or adjust to fill in the gaps when one eye or the other is not used or is looking at something different. Since one eye is looking through the tube and the other is looking at the hand, the two views blend to form an optical illusion – a hole in the centre of the hand.

- ➤ Have them roll a sheet of paper into a tube with a diameter of about 2.5 or 3 cm.
- ➤ With both eyes open, they hold the tube up to one eye and place the other hand, palm facing them, beside the tube.
- ➤ Suggest that they move their hand forward and back along the tube and stop when they see an image. Ask what they see. Tell them that we call this an optical illusion.

ACTIVITIES

The following activities demonstrate the importance of visual cues and visual perception and the role our eyes and brain have in processing these cues.

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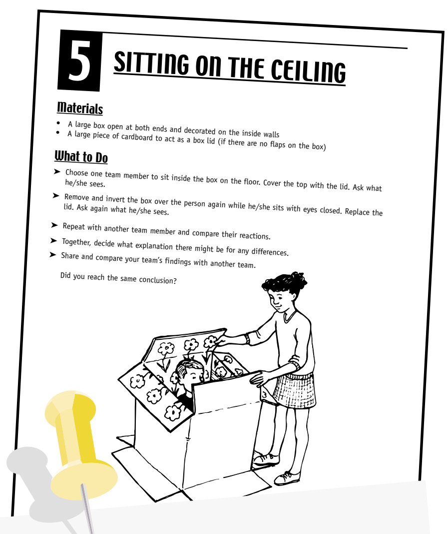
Materials:

For each team or group:

- a large box open at both ends and decorated on the inside walls
- a large piece of cardboard to act as a box lid (if there are no flaps on the box)
- *Sitting on the Ceiling, Student 5*



5 SITTING ON THE CEILING

Materials

- A large box open at both ends and decorated on the inside walls
- A large piece of cardboard to act as a box lid (if there are no flaps on the box)

What to Do

➤ Choose one team member to sit inside the box on the floor. Cover the top with the lid. Ask what he/she sees.

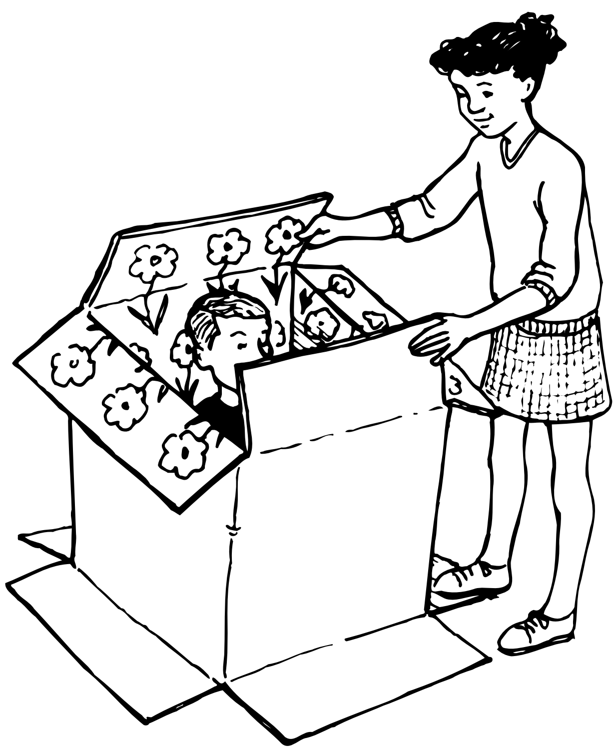
➤ Remove and invert the box over the person again while he/she sits with eyes closed. Replace the lid. Ask again what he/she sees.

➤ Repeat with another team member and compare their reactions.

➤ Together, decide what explanation there might be for any differences.

➤ Share and compare your team's findings with another team.

Did you reach the same conclusion?



Hints:

- **Decorate the inside of the box with wallpaper, coloured shapes, or magazine pictures.**
- **Locate the boxes and copies of *Sitting on the Ceiling, Student 5* in an area where the students can do this activity with a partner.**

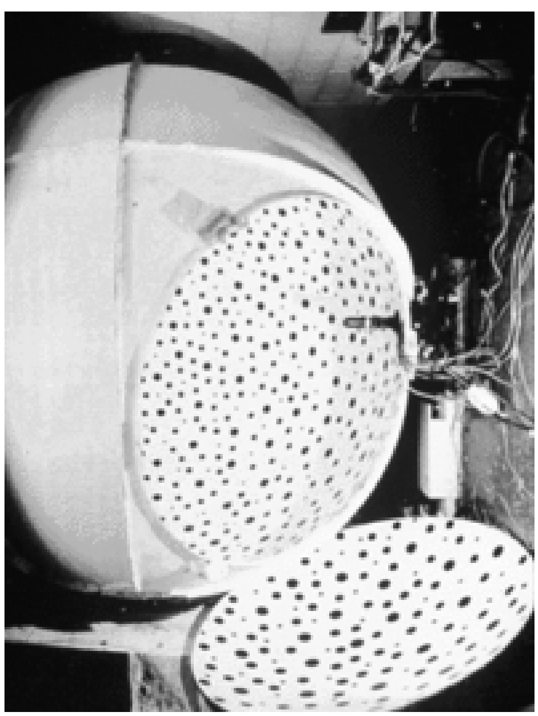
ACTIVITIES

- ➤ Have a few students prepare the boxes ahead of time.
- ➤ Read the directions together and answer any questions the groups may have.
- ➤ In a follow-up discussion, ask what explanation there might be for any differences mentioned.
- ➤ Help students see the importance of our eyes in helping to orient us to UP and DOWN, by asking what sense(s) they used to decide if the box was right side up or upside down.
- ➤ Point out that even though some students may have felt somewhat disoriented, they still had the floor to help orient themselves. Relate this to the experience of the astronauts in microgravity who have no UP or DOWN cues at all.

Extensions:

- ➤ Have the students imagine what it might be like to be in a room that has spherical walls and write a paragraph about what could happen in a room with no UPs or DOWNs. Suggest that they tell about their adventure in a circle diagram with illustrations.

- ➤ Discuss the consequences that disorientation may have on astronauts in the Spacelab.



View of CRESTech's spherical room used for STS-90 training.

ACTIVITIES

Seeing Is Not Always Believing

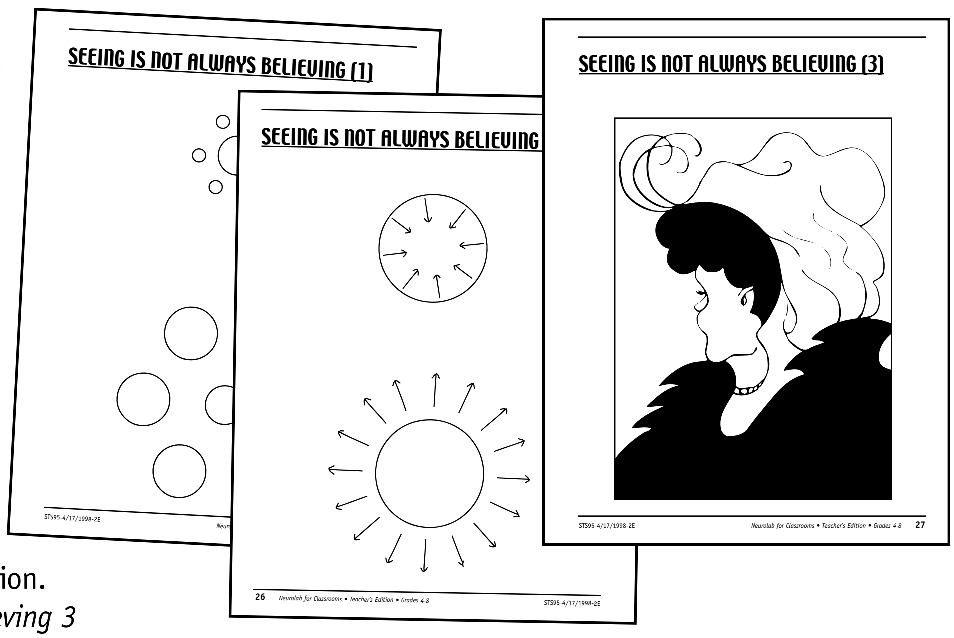
Purpose:

To demonstrate that your eyes can fool your brain – an optical illusion.

Usually, your eyes and your brain work together to tell you that what you are seeing is what is really there. But sometimes an object or shape you are used to looking at one way can appear totally different when its surroundings are changed. When this happens, your eyes see something that your brain tells you cannot be true. In other words, your eyes and your brain disagree about what is real!

Materials:

- *Seeing is Not Always Believing, 1-3*
- *Impossible Shapes, 4-5*
- overhead projector
- *Seeing Is Not Always Believing, Student 6-9*



➤ Show *Seeing Is Not Always Believing 1* on the overhead projector. Discuss why the dot seems larger.

➤ Show *Seeing Is Not Always Believing 2* and talk about why one circle seems larger. Introduce the term optical illusion.

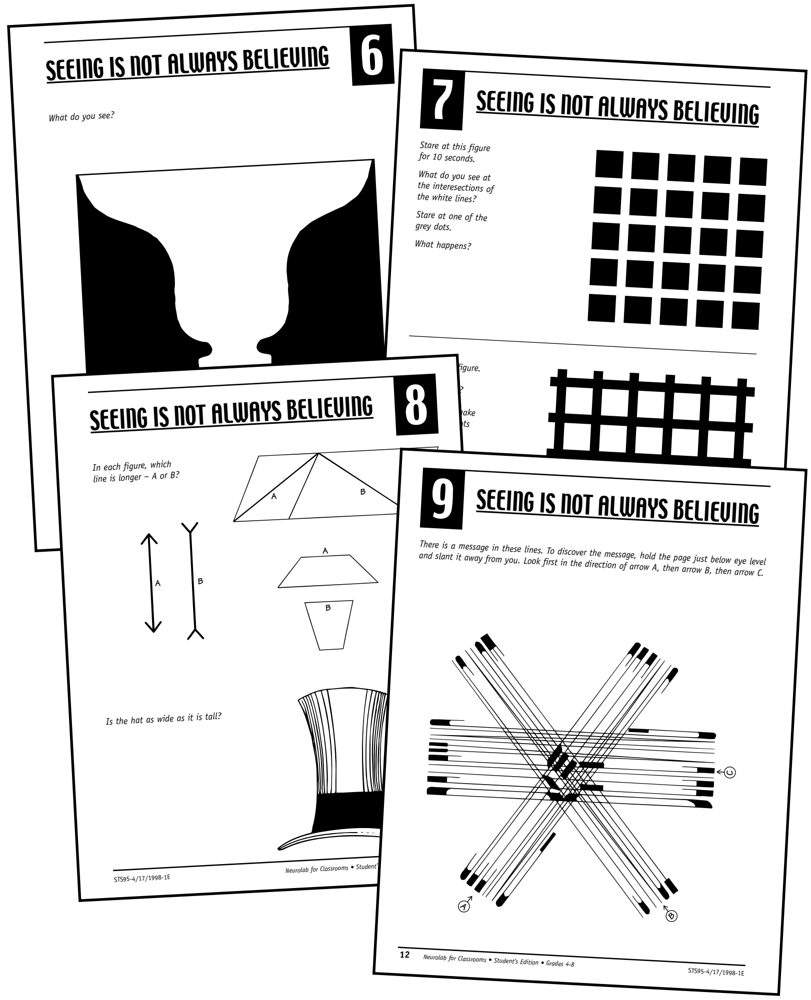
➤ Show *Seeing is Not Always Believing 3*
Help the students identify the images of the two women.
Ask the students:
- who saw the older woman first
- who saw the younger woman first
- who was able to see both women at first glance

Suggest that students tilt their heads to look at the illusion. Ask if there is a difference in what they see?

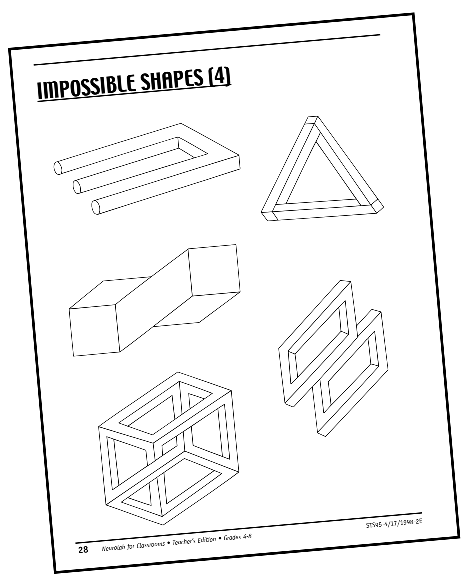
➤ Recall with the students how vision works and draw some conclusions about what caused the illusions.

We do not come across illusions as strong as these in daily life because there are usually many visual cues in our surroundings to help our brain interpret what it sees. The sample illusions are confusing because the images have been simplified – the brain does not receive the contextual cues that usually surround the objects, so it must guess as to what it "sees".

ACTIVITIES



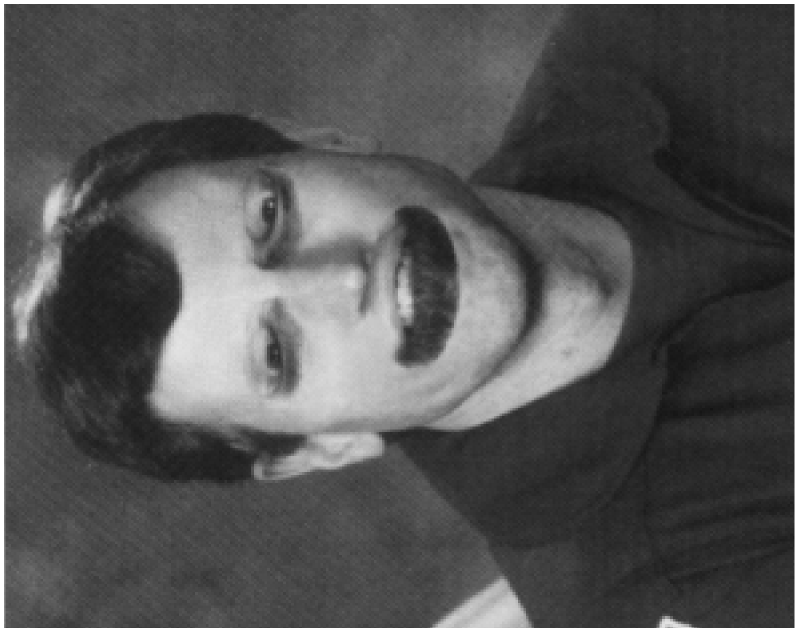
- ➤ Divide the class into groups and choose a recorder for each group to make notes about each group member's reactions.
- ➤ Suggest that each group member individually look at the images on the worksheets then discuss reactions in the group.
- ➤ Have students discuss a procedure by which astronauts could train for the possibility of vision distortion, defending and supporting their suggestions.
- ➤ Point out that once you become familiar with one of these illusions, they become easier to recognize because your brain has adapted to the new information.

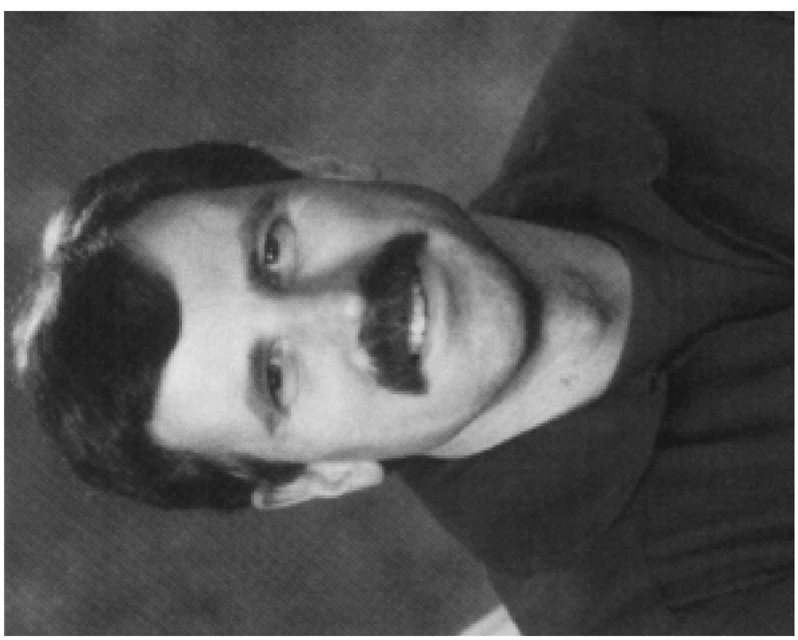


Extensions:

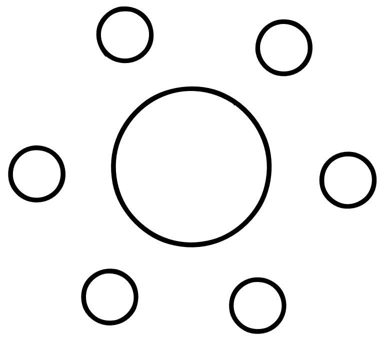
- ➤ Discuss the way in which a 'flip book' can be used to show "moving images."
- ➤ Discuss how and why lights and mirrors are used in supermarkets. (To make products stand out as special and to make the store seem larger.)
- ➤ Show *Impossible Shapes (4)* that are examples of flat two-dimensional drawings. Have students note that their eyes want to see these as three-dimensional objects even though they could never actually be constructed.

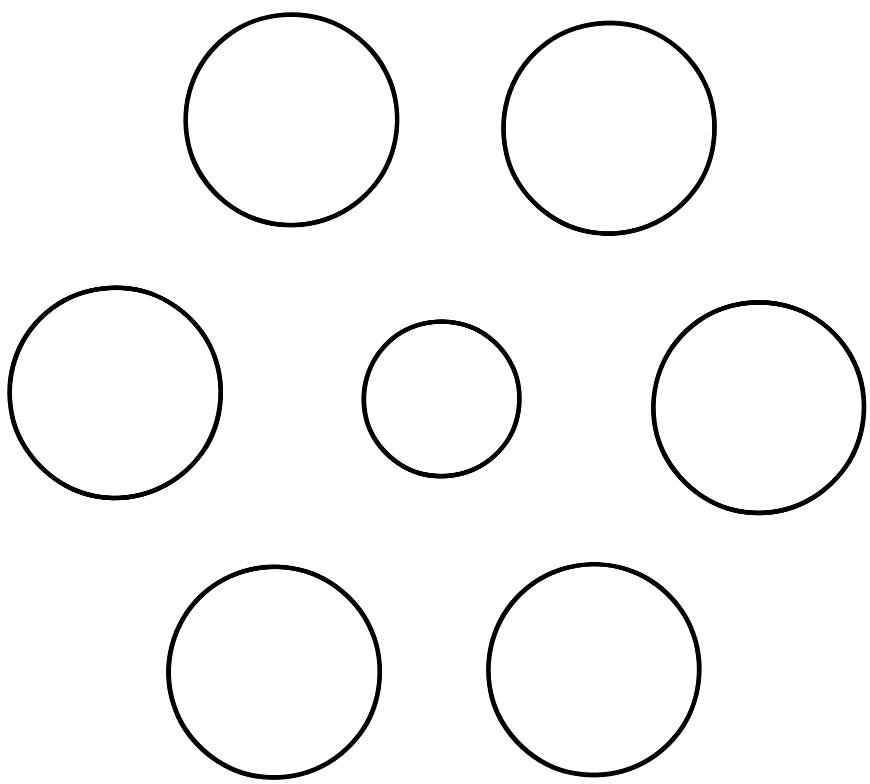
WHAT'S WRONG HERE?



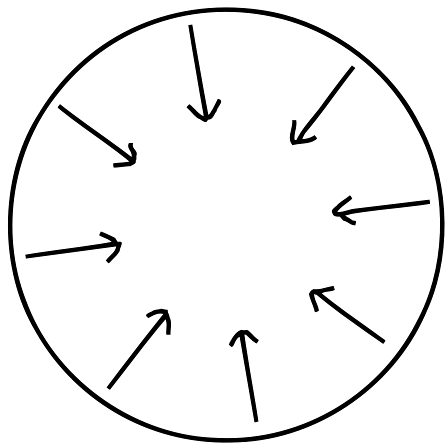


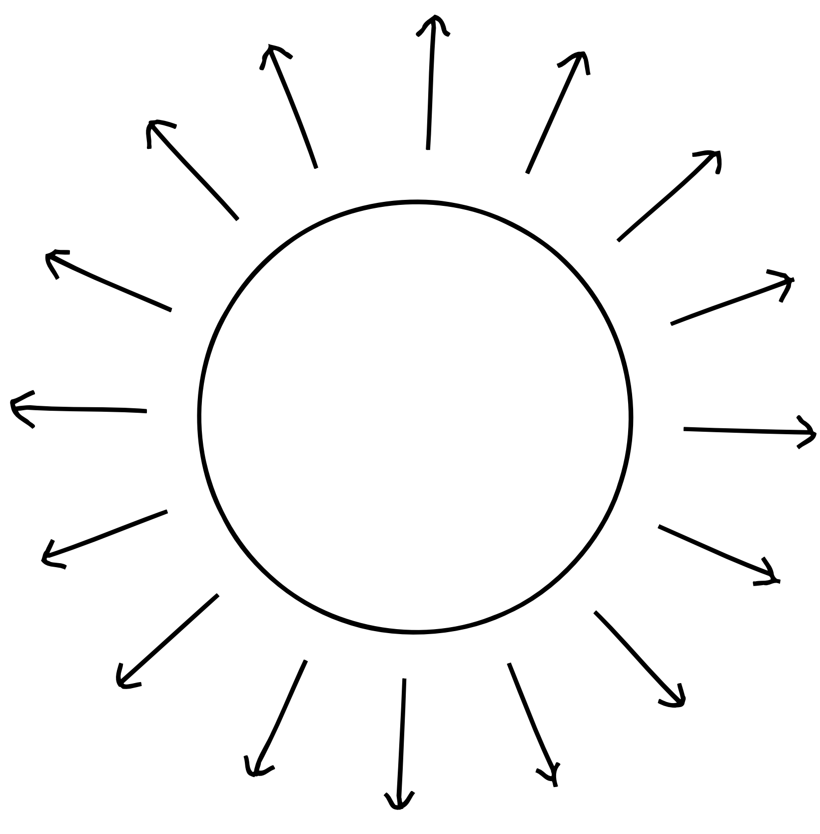
SEEING IS NOT ALWAYS BELIEVING (1)





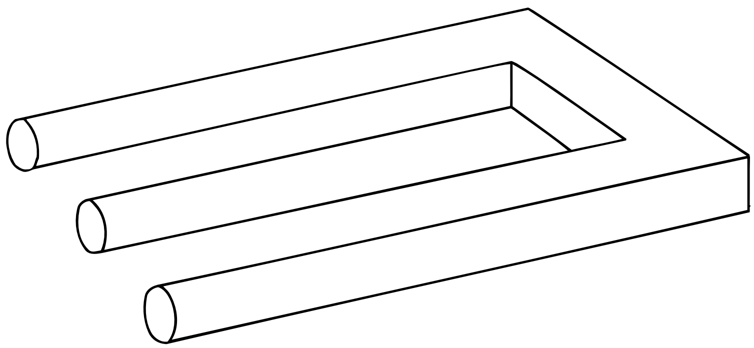
SEEING IS NOT ALWAYS BELIEVING (2)

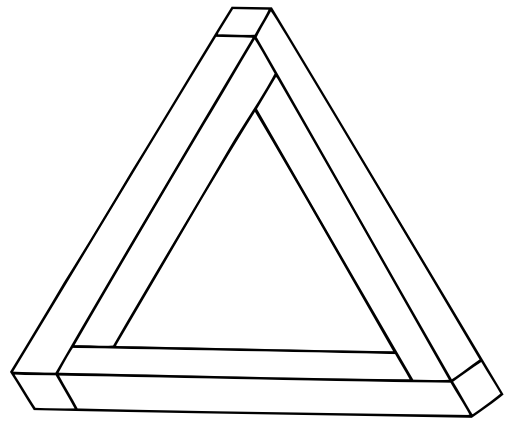


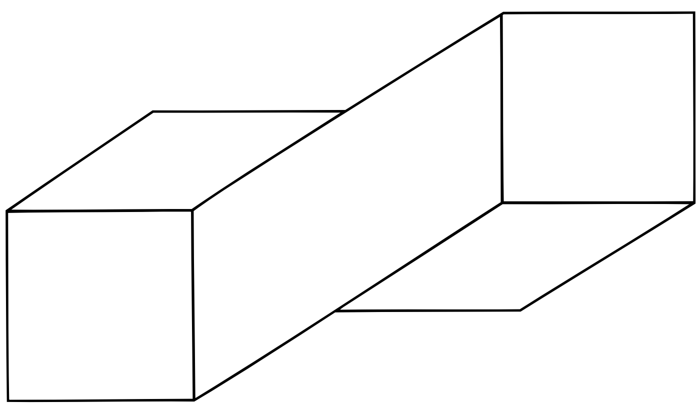


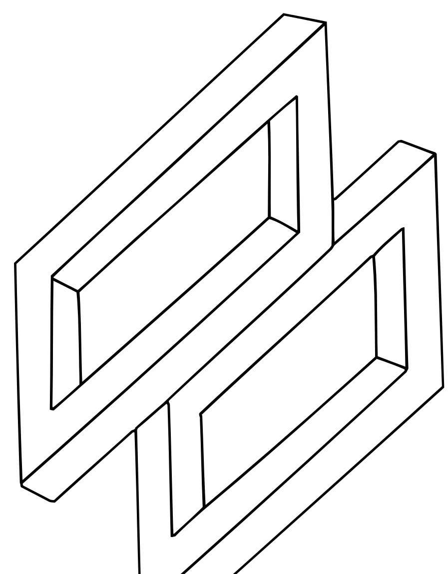
SEEING IS NOT ALWAYS BELIEVING (3)

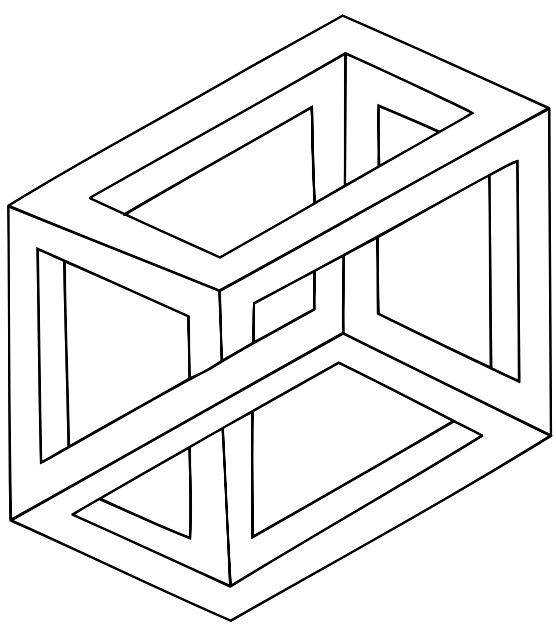
IMPOSSIBLE SHAPES (4)











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The Space Shuttle, Dr. Robert Thirsk, Canadian Space Agency (1997)

The Space Environment, Dr. Robert Thirsk, Canadian Space Agency (1997)

Microgravity Speaker Handbook, Canadian Space Agency (1994)

Microgravity – A Teacher's Guide, NASA (1997)

ON-LINE RESOURCES

Canadian Space Agency Web Page:
http://www.space.gc.ca

CSA KidSpace:
http://www.space.gc.ca/kidspace

Newrolab Mission Web Page:
http://www.space.gc.ca_sectors/human_presence/en/canastronauts/astro/sts90/index.htm
then click Kid Space!

Link to NASA website :
http://lsda.jsc.nasa.gov

Neuroscience For Kids
http://weber.s.washington.edu/~chudler/neurok.html

Neurolab Online:
http://quest.arc.nasa.gov/neuron/

DAVE WILLIAMS STS-90 MISSION CREST

The STS-90 Mission, known as Neurolab, sees the Space Shuttle Columbia *transformed into an orbiting laboratory for neurosciences. The EEG (electroencephalogram) waves emanating from the shuttle represent the experiments to be conducted during the mission. There are four waves: one for each of the payload crew members who will be carrying out the experiments.*

The constellation Ophiucus ("The Serpent Bearer"), associated with Asclepius, the Greek god of medicine, appears in the upper right side of the patch. The nine stars in the constellation represent the nine crew members who have trained for STS-90. The cadueus on the left is the international emblem of physicians. The traditional wings of the emblem have been modified to aviation "flight wings" symbolizing Dave Williams' combined experience as medical doctor, neurophysiologist, and mission specialist.

A graphic illustration of a neuron stretches over the Earth below, representing the application of Neurolab's research to terrestrial neurosciences.

Canadian Space Agency Educational Outreach Reply Form

The Canadian space Agency through its educational outreach program seeks to involve teachers and students in its educational activities. To this end, please provide us with your comments and suggestions on the material in this package.

Your opinion counts! Please take a moment to fill out the evaluation form below and return it to:

Manager, Youth Outreach, Communications Directorate, Canadian Space Agency
6767 route de l'Aéroport, Saint-Hubert, Quebec J3Y 8Y9

Indicate the extent to which you agree with each statement by circling ONE number in the right hand column	**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
As an instructor, I found the STS-90 outreach material useful.	1	2	3	4	5
The students responded positively to the material.	1	2	3	4	5
I would welcome similar material for future missions.	1	2	3	3	3
The presentation of the material attracted learners.	1	2	3	4	5
The content of the material was engaging.	1	2	3	4	5
The science content was appropriate for the level of the learners.	1	2	3	4	5
The delivery vehicle was the best one to use in this case.	1	2	3	4	5
I would prefer more general information to make my own lessons.	1	2	3	4	5

Prov. or Terr.: ______________________

Put me on your mailing list: ❑

Subject taught: ______________________

NAME: ______________________

Level materials were used: ______________________

ADDRESS: ______________________

Which of the following best describes how the materials were used:

❑ **A.** Background information ❑ **B.** Group discussion ❑ **C.** Integration into existing curricula ❑ **D.** Lecture
❑ **E.** Group activities ❑ **F.** Demonstration ❑ **G.** Hands-on activities
❑ **H.** Interdisciplinary activities ❑ **I.** Other: Please specify: ______________________

Which features of the material were most useful? ______________________

Which features need to be improved? ______________________

Additional comments: ______________________